Nevada National Security Site Performance Assessment Updates for New Waste Streams

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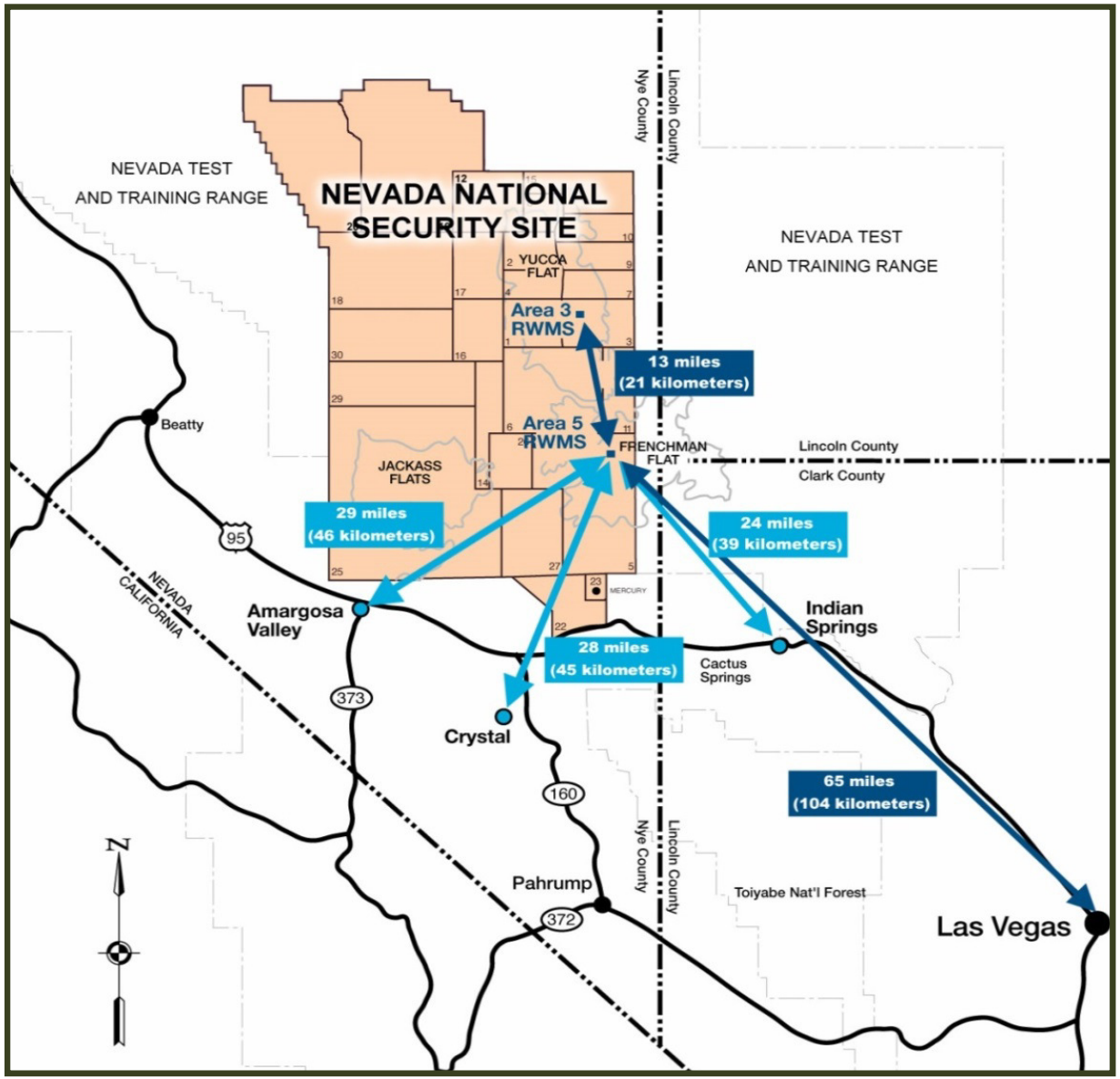
Performance and Risk Assessment Community of Practice
Annual Technical Exchange Meeting
December 11 and 12, 2014

Outline

- Area 5 Radioactive Waste Management Site (RWMS)
  - Introduce Area 5 RWMS design and performance
- How does the performance assessment (PA) process manage future inventory uncertainty?
- How to decide if a new or revised waste stream is acceptable under the Disposal Authorization Statement (DAS)?
  - Unreviewed disposal question (UDQ) process
- Experience and examples

Area 5 RWMS

- Located in Frenchman Flat on the Nevada National Security Site (NNSS)
- Remote location, 65 miles northwest of Las Vegas, NV
- Site Federally owned, surrounded by Federally controlled land
- Regional population density very low due to lack of water resources
- Residual contamination from weapons testing in close proximity



Site Characteristics

- Thick (> 235 m), dry vadose zone of alluvial sediments
- Less than 12 cm of rainfall per year
- Arid shrubland - potential evapotranspiration (ET) 12X precipitation
- No evidence for percolation below plant root zone in last 10,000 – 15,000 years
- No surface water or shallow groundwater
- No mineral resources
- Infertile soils

Operational History

- On-site low-level waste (LLW) disposal facility in operation since 1961 (> 50 years)
  - Predates DOE Waste Management Orders (1988)
  - Initial performance assessment approved 1998
- Off-site waste accepted since 1978
- Regional DOE disposal facility since 1997
- Accepts DOE LLW, Mixed LLW, Asbestiform waste, classified waste, and in the past has disposed transuranic (TRU) waste

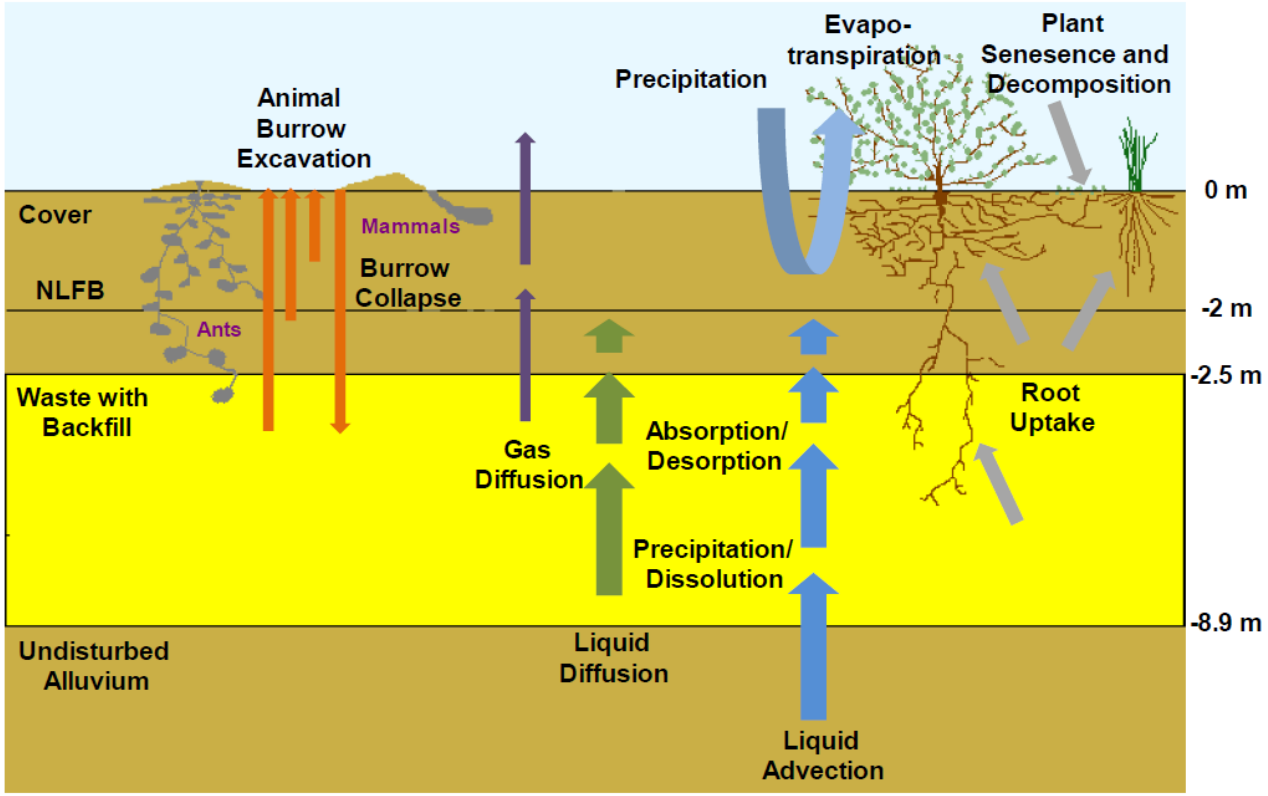
Facility Design

- Most LLW disposed by shallow land burial (SLB) in unlined pits and trenches
  - Most waste containerized is wooden boxes, steel drums or boxes
- Mixed LLW historically disposed in unlined pits and trenches

- Mixed LLW currently disposed in a double lined RCRA-compliant cell
- High specific activity and TRU waste disposed by Greater Confinement Disposal (GCD) in 36 m deep uncased boreholes
- Facility relies on natural barriers for containment
- Closure with a monolithic vegetated evapotranspirative cover planned

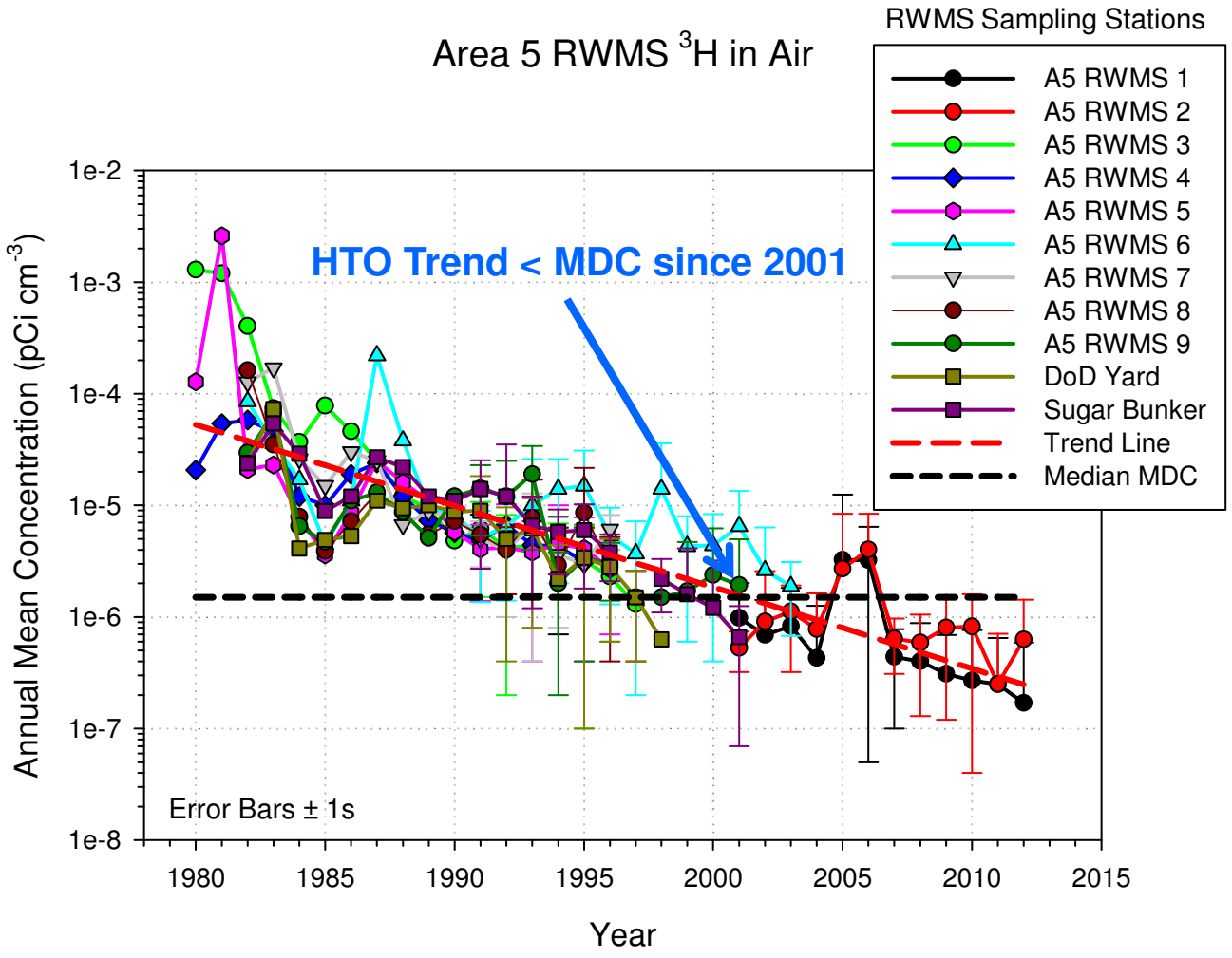
Conceptual Model

- No groundwater pathway
- Release upward to surface soil and atmosphere
- Conceptual model expectation
  - Volatiles in air (e.g., HTO, Rn-222)
  - Mobile nuclides in cover soil and biota (e.g., HTO, Tc-99, Pb-210)



Monitoring: Current Site Performance

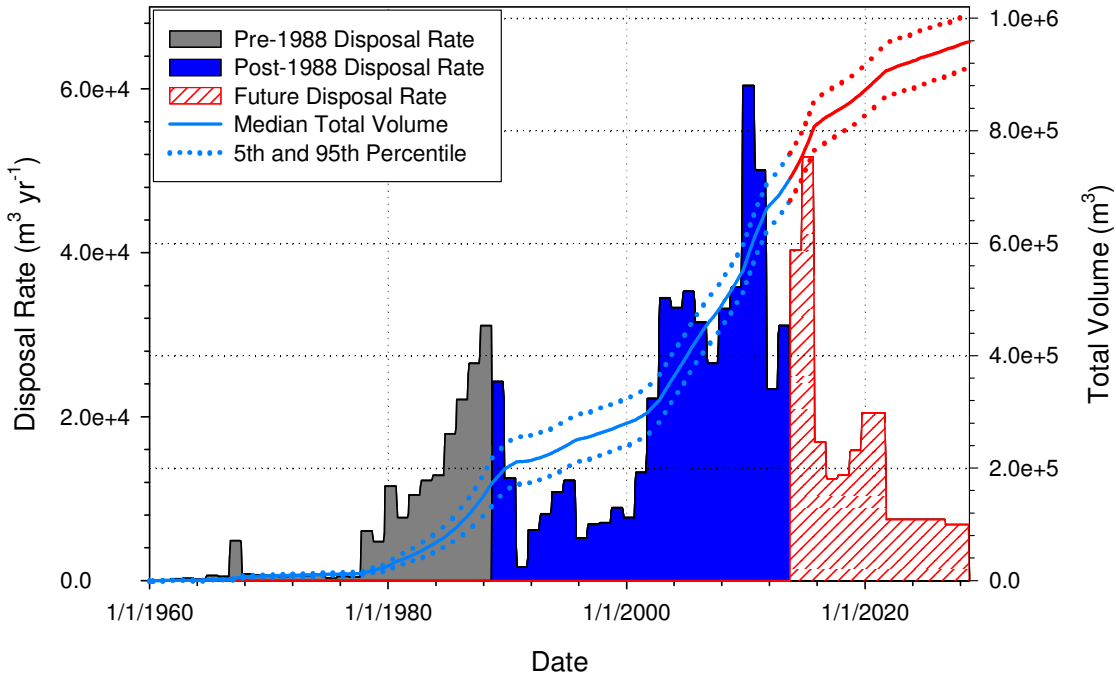
- No water percolation below 2 m in vegetated weighing lysimeter (20 year record)
- No evidence of water percolation into or through waste (15 year record)
- No contamination ever detected in uppermost aquifer
  - Includes HTO measurements with a few pCi/l detection limit



- Air monitoring: HTO, ^{239,240}Pu, and ^{241}Am detected sporadically at levels well below Derived Concentration Standards

Future Inventory Uncertainty

- Inventory (volume and nuclide composition) will change over time
- Significant change possible over decades long operational period
- Data collection about generators' future waste can reduce uncertainty in the near-term
- Economic and political factors are important in the long-term



Future Inventory Uncertainty (cont.)

- For example: In 1961 could we have predicted:
  - Funding increases/decreases
  - Changing mission (Chernobyl and Fukushima versus a nuclear renaissance)
  - Price of uranium
  - Nuclear arms control treaties
  - Changing regulations (RCRA, Nuclear Waste Policy Act, Waste Incidental to Reprocessing, 10 CFR 61 Update)
  - Changing transportation availability and cost
  - Availability/Unavailability of alternative disposal sites (government and commercial)
  - Stakeholder concerns
  - International events (Sept. 11, 2001 and dirty bombs)
- All these issues have had some impact on inventory

PA/CA Process: Design for Change

- Inventory forecasting has limits – Have to plan for change

- Pre-operations
  - Estimate an inventory
  - Estimate performance, assess likelihood of compliance
  - Optimize a facility design
  - Derive waste acceptance criteria (WAC) (concentration/activity limits)

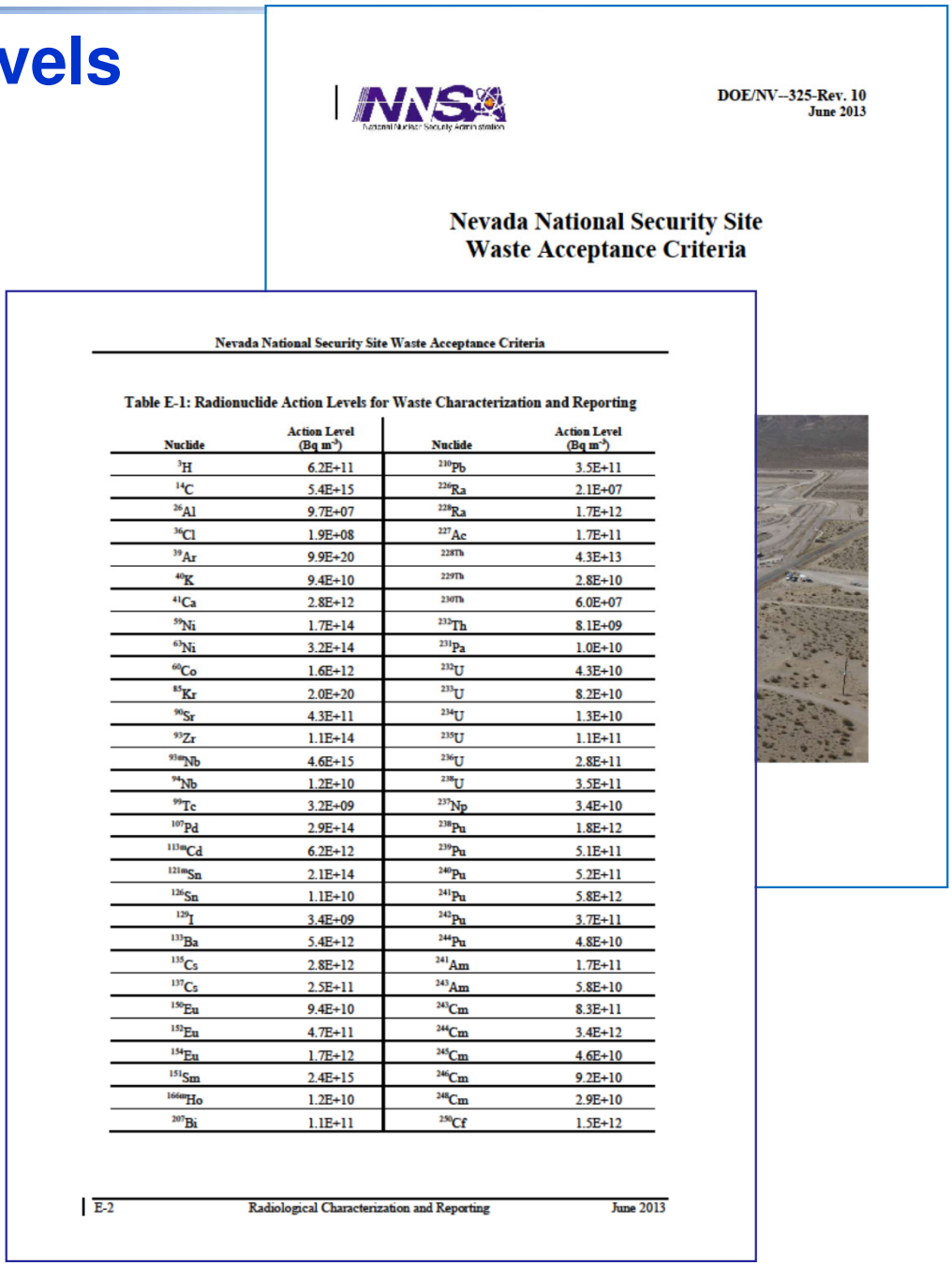
- Operations under DAS
  - Assess WAC compliance (e.g., sum of fractions (SOFs) calculation)
  - All changes must be evaluated and reviewed
  - Revise PA and WAC as necessary

- Closure
  - Final inventory known
  - Final performance estimated, confirm compliance

PA Derived WAC: Action Levels

Action Level: **Disposal facility** radionuclide concentration that will comply with all performance objectives.

- Not a waste package limit
- Used to screen waste streams
- Derived from the PA model
  - Minimum concentration meeting all performance objectives
- Table E-1 in Waste Acceptance Criteria



NNSA National Nuclear Security Administration

DOE/NV--325-Rev. 10
June 2013

Nevada National Security Site
Waste Acceptance Criteria

Nevada National Security Site Waste Acceptance Criteria

Table E-1: Radionuclide Action Levels for Waste Characterization and Reporting

Nuclide	Action Level (Bq m^{-3})	Nuclide	Action Level (Bq m^{-3})
^{3}H	6.2E+11	^{210}Pb	3.5E+11
^{14}C	5.4E+15	^{226}Ra	2.1E+07
^{26}Al	9.7E+07	^{228}Ra	1.7E+12
^{36}Cl	1.9E+08	^{227}Ac	1.7E+11
^{39}Ar	9.9E+20	^{228}Th	4.3E+13
^{40}K	9.4E+10	^{229}Th	2.8E+10
^{41}Ca	2.8E+12	^{230}Th	6.0E+07
^{59}Ni	1.7E+14	^{232}Th	8.1E+09
^{63}Ni	3.2E+14	^{231}Pa	1.0E+10
^{60}Co	1.6E+12	^{232}U	4.3E+10
^{85}Kr	2.0E+20	^{233}U	8.2E+10
^{90}Sr	4.3E+11	^{234}U	1.3E+10
^{93}Zr	1.1E+14	^{235}U	1.1E+11
^{93m}Nb	4.6E+15	^{236}U	2.8E+11
^{94}Nb	1.2E+10	^{238}U	3.5E+11
^{99}Tc	3.2E+09	^{237}Np	3.4E+10
^{107}Pd	2.9E+14	^{238}Pu	1.8E+12
^{113m}Cd	6.2E+12	^{239}Pu	5.1E+11
^{121m}Sn	2.1E+14	^{240}Pu	5.2E+11
^{126}Sn	1.1E+10	^{241}Pu	5.8E+12
^{129}I	3.4E+09	^{242}Pu	3.7E+11
^{133}Ba	5.4E+12	^{244}Pu	4.8E+10
^{135}Cs	2.8E+12	^{241}Am	1.7E+11
^{137}Cs	2.5E+11	^{243}Am	5.8E+10
^{150}Eu	9.4E+10	^{243}Cm	8.3E+11
^{152}Eu	4.7E+11	^{244}Cm	3.4E+12
^{154}Eu	1.7E+12	^{245}Cm	4.6E+10
^{151}Sm	2.4E+15	^{246}Cm	9.2E+10
^{166m}Ho	1.2E+10	^{248}Cm	2.9E+10
^{207}Bi	1.1E+11	^{250}Cf	1.5E+12

E-2 Radiological Characterization and Reporting June 2013

Operations: Unreviewed Disposal Question (UDQ) Process

Purpose

- To identify and document changes potentially affecting the Radioactive Waste Management Basis
  - PA, composite analysis, closure plan, disposal authorization, waste acceptance criteria, monitoring plan
  - Scope goes beyond waste stream reviews

- To identify significant changes requiring additional analysis
  - Confirm PA performance objectives can be met

- To notify National Nuclear Security Administration Nevada Field Office (NNSA/NFO) of significant changes that require their review and approval

The UDQ Process (continued)

Step 1: Identify and describe proposed action

- For example: Disposal of new waste stream or nuclide

Step 2: Evaluate proposed action against four criteria

- Does the proposed action:
  - Involve a change in radionuclide inventory?
  - Require a change in facility design or closure plans; or require imposition of operational constraints or conditions?
  - Alter the likelihood of a feature, event, or process; or significantly change a parameter value?
  - Require a change in waste acceptance criteria, the performance assessment; or the disposal authorization statement?

- Yes to any question identifies a ***potential*** UDQ
- New waste streams are potential UDQs
- Revised waste streams may be potential UDQs

The UDQ Process (continued)

Step 3: Exclude minor inventory changes

- Exclusions
  - Action level SOFs ≤ 1.0
  - Action level SOFs ≤ 10, waste volume ≤ 100 m^3
  - Radionuclide without an action level, total inventory less than 3.7E7 Bq

$$SOF = \sum_{i=1}^{n} \frac{\text{Representative Waste Concentration}_i}{\text{Action Level}_i}$$

$SOF < 1$	$SOF = 1$	$SOF > 1$
$Dose < Limit$	$Dose = Limit$	$Dose > Limit$

The UDQ Process (continued)

Step 4: Perform inventory screening

- Calculate available capacity SOFs
- Available capacity – Activity required to make site concentration equal to action level
- If available capacity SOFs ≤ 0.01, proposed action is screened out of UDQ process

$$Available\ Capacity\ SOFs = \sum_{i=1}^{n} \frac{\text{Representative Concentration}_i * \text{Volume}}{\text{Available Capacity}_i}$$

The UDQ Process (continued)

Step 5: Is proposed action covered by previous special analysis (SA)?

- If yes, proposed action is not a UDQ
  - Waste stream revisions – SA for earlier revision may apply to current revision if changes are not significant
  - Radionuclides without action level – SA derived inventory limits

Step 6: Proposed action is a positive UDQ

- Perform SA to determine if proposed action can meet DOE Manual 435.1-1 performance objectives
- Notify NNSA/NFO that waste stream acceptance is a significant change
- NNSA/NFO will determine if Low-Level Waste Federal Review Group review is necessary

Resolution of Positive UDQs

New or revised waste streams

- Evaluate with PA GoldSim model
- Add waste stream inventory to disposed inventory
- Run PA calculations
  - Compare results with DOE 435.1-1 Manual performance objectives
- Document SA results in written document
- If performance objectives are met, recommend approval without conditions
- NNSA/NFO reviews SA and approves/disapproves waste stream
- If performance objectives are not met, explore options
  - Alternative disposal options
  - Include waste form or container effects in model
  - Revise waste stream

UDQ Process: Experience

- ~ 10 years of operational experience
- 150 – 200 potential changes identified/reviewed per year
- <12 changes per year found to be significant (positive UDQs)
- Common UDQs
  - Large radionuclide inventories or inventories increases (exceed action levels)
  - Radionuclides not evaluated in the PA (no action level)
  - Heat generation
- Most are resolved in a few days

Annual Update

- PA group conducts an annual review of:
  - Site operations (including waste inventory disposed)
  - Facility design and management plans
  - Research developments and monitoring results
- Annual review asks:
  - Does the PA need to be revised?
  - Has anything changed that would invalidate the PA?
  - Does the site comply with the performance objectives?
- Annual re-calculation of PA results
- Results published annually and reported to DOE/EM HQ

Defense Nuclear Stockpile Thorium Waste

- 11,600 cubic meters (m^3) high purity Th
- ^{230}Th and ^{226}Ra and exceeded WAC action levels
- Potential to generate ^{222}Rn
- Special Analysis perfomed
- Thick (25 ft) mono-layer cover designed to attenuate Rn flux density

Summary

- The Area 5 RWMS is well suited for disposal of LLW
- The radionuclide composition of waste has changed significantly over time
- Changes must be identified, evaluated, reviewed, and approved
- Changes are managed by:
  - Deriving WAC from the PA model
  - UDQ process applied to every new or revised waste stream
  - Annual review and updating of PA results